REMARKS/ARGUMENTS:

This Reply is in response to the Office Action mailed on July 11, 2003 and is thus timely filed. In the Office Action, claims 1-37 were all rejected. In this Reply, claims 1, 4-7, 21, 26, 33, and 37 have been amended. No new matter has been added.

Applicants affirm their election with traverse made on June 19, 2003 by the undersigned, Neil R. Jetter, to select claims 1-37 and cancel claims 38-43 pursuant to a restriction requirement. Accordingly, claims 38-43 are cancelled, without prejudice.

As amended, the claims now presented overcome the following objections/rejections:

1. Indefiniteness (35 USC 112) determined relative to former claims 1-6 and 8-37;

2. Indefiniteness relative to former claims 1-36;

3. Indefiniteness relative to former claims 1 and 33 relating to the formerly recited "adapted to" language;

4. Indefiniteness relative to claims 21 and 36 resulting from the recital of a "low K dielectric". Although the "low K dielectric" language has been modified by Applicants, Applicants note that such term is clearly defined on page 13, lines 4-5 as a material having a dielectric constant less than that of silicon dioxide.

The disclosure was objected to by the Examiner because of a determination that not all of the figures shown in FIG. 1 were defined under the section entitled "BRIEF DESCRIPTION OF DRAWINGS." In response, the "BRIEF DESCRIPTION OF DRAWINGS" has been amended by Applicants to include a description of FIGs. 1(a)-(e), respectively. Figure 13 was objected to by the Examiner as failing to comply with 37 CFR 1.84(p)(5) because of the omission of (a)-(c) designations. To overcome this objection Applicants have provided substitute drawings which

include identification of FIGs. 13 (a)-(c). Accordingly, the objections regarding the drawings are now overcome.

Turning now to rejections based on art, originally filed claims 1-37 were rejected based on numerous references, since the instant claims were interpreted as "claiming a slurry comprising a solution of iodine, fluorine, bromine HI, potassium iodate, sulfuric acid, hydrochloric acid or carbonic acid (i.e., carboxylic acid), as well as, additional components specifically defined in the dependent claims." The other recited limitations (i.e., soft layer, etc.) were not regarded as providing any patentable subject matter. The references cited included Sasaki et al., Kondo et al, Ichinose et al., WO 00/24842 to Mahulikar, Wu et al., Zhang et al., Takashima et al., Hardy et al., Yano et al. and Nishimoto et al.

Applicants will now review the claimed invention as now recited in amended claim 1, which is believed to clearly distinguish over the cited art. Amended claim 1 recites a slurry for chemical mechanical polishing (CMP) of a copper or silver containing film. The slurry comprises a solution including at least one species selected from the group consisting of a polyhalide ion, or the halogens I_2, Br_2 or F_2. The term "halogen" is used in the application and is also well known in solution chemistry and refers to diatomic Group VIIA molecules, such as I_2, Br_2 or F_2. Halogens in solution generally produce characteristic colors to the solution, such as a purple color when Br_2 is present. The phrase "polyhalide ion" is also well defined in solution chemistry as a molecular ion including at least two Group VIIA species, the species not necessarily being different, such as I_3. Although the term "polyhalide ion"' is not disclosed in the application, it is well known in solution chemistry that the mixing of a halogen with a halide ion forms a polyhalide ion, such as:

$$I_2(s) + I^-(aq) \leftrightarrow I_3^-$$

Polyhalide ions can be contrasted with halide ions, which are also well defined and refer to monoatomic ions, such as F^-, Cl^- and Br^-. Halide ions are not known to impart color to a solution.

The recited polyhalide ion or halogen species reacts with the copper or silver film to form a soft layer on a surface of the film. The soft layer can be AgI, CuI, AgBr or CuBr, for example. Such metal halide layers are soft layers as they have a hardness less than that of the copper or silver film. This which facilitates a low defect CMP process, such as that obtainable using either no particles, or soft particles which have a hardness less than the metal layer being polished in the slurry.

The invention may be contrasted with conventional copper CMP slurries which include oxidizers, such as KIO_3 which form a copper oxide layer using the strongly oxidizing iodate ion IO_3^-). Specifically, a copper oxide (Cu_2O or CuO) layer is formed on the surface of the copper (or silver film) during the CMP process. Copper oxide (Cu_2O) is known to have a Mohs hardness of 3.5 to 4 and CuO to have a Mohs hardness of 3.5 to 4, which are both substantially greater than the Mohs hardness of copper films (2.5 to 3) or silver films, or common underlying dielectric layers such as silicon dioxide. Thus, the invention substantially overcomes problems associated with copper and silver CMP which relates to the need for abrasive particles to polish the hard oxide surfaces formed by the oxidizing species in the slurry. Specifically, the formation of a soft surface layer having a hardness less than the copper film, as opposed to a hard oxide film, permits a reduction in dishing, erosion, surface scratching, peeling, and also a reduction in the polishing of underlying layers. In addition, the invention provides very high polishing selectivity, such as least 50 for removal of a copper or silver film relative to a silicon dioxide, alumina or a low K dielectric layer which has a dielectric constant less than silicon dioxide.

Sasaki discloses a polishing method including the steps of forming a film made of material containing a metal as a main component over a substrate having depressed portions on a surface thereof so as to fill the depressed portions with the film, and polishing the film by a chemical mechanical polishing method using a polishing agent containing a chemical agent responsible for forming a protection film on a surface of the film by reacting with the material containing a metal as a main component, thereby forming a conductive film in the depressed portions. In one embodiment identified by the Examiner, Sasaki discloses a slurry including hydrochloric acid. Although halide ions (Cl^-) may be available in solution, no halogen or polyhalide ions as recited by Applicant are provided.

Kondo discloses a polishing technique wherein scratches, peeling, dishing and erosion are suppressed. A metal film formed on an insulating film having a groove is polished with a polishing solution containing an oxidizer and a substance which renders oxides water-soluble, but not containing a polishing abrasive. KIO_3 is disclosed by Kondo to provide the iodate ion which oxidizes the surface to be polished to produce a hard oxide layer. Although iodate (IO_3^-) ions may be present in the slurry, no halogen or polyhalide ions as recited by Applicant are provided.

Ichonese discloses a method of etching material as a transparent conductive film, a method of producing a semiconductor device, and an etchant. The methods include the steps of disposing paste on material wherein the paste includes an etching solution and at least one kind of fine particles. Although in one embodiment identified by the Examiner hydrochloric acid is disclosed, as noted above although halide ions (Cl^-) may be available in solution, no halogen or polyhalide ions as recited by Applicant are provided.

WO 00/24842 discloses a slurry including KIO_3, and a fluoride salt. The KIO_3 is a strong oxidizer which forms a hard oxide layer. Although halide ions (I^- and F^-) may be available in the slurry solution, I^- and F^- are unreactive to one another. Thus, no halogen or polyhalide ions as recited by Applicants are provided.

Zhang discloses apparatus, procedures and compositions for avoiding and reducing damage to low dielectric constant materials and other soft materials, such as Cu and Al, used in fabricating semiconductor devices. The slurry may or may not also contain soft abrasive particles, which replace the hard abrasive particles of conventional slurries. Use of soft abrasive particles can reduce the role of mechanical abrasion in the CMP process. Use of this slurry in CMP can reduce surface scratches and device damage. Zhang does not disclose or suggest the halogen or polyhalide ions recited by Applicants.

Takashima discloses a metal polishing pad having a functional group which captures a metal ion, a polishing apparatus comprising an apparatus of contacting a polishing subject having a metal surface with the polishing pad, and applying pressure uniformly between them. In one embodiment Takashima discloses a solution including an oxidizer (an iodate). The iodate ion (IO_3^-) is a strong oxidizer which forms a hard oxide layer. Although iodate ions are available in the slurry solution, no halogen or polyhalide ions as recited by Applicant are provided.

Hardy discloses a family of working liquids useful in modifying exposed surfaces of wafers for semiconductor fabrication are provided along with methods of modifying exposed surfaces of wafers for semiconductor fabrication utilizing such a family of working liquids, and semiconductor wafers. The working liquid of the invention is a solution of initial components, the components comprising: an oxidizing agent; an ionic buffer; a passivating agent; a chelating agent selected from iminodiacetic acid and salts thereof; and water. In one embodiment

identified by the Examiner ammonium chloride is disclosed. However, as noted above although halide ions (Cl^-) may be available in solution, no halogen or polyhalide ions as recited by Applicant are provided.

Yano discloses provide an aqueous dispersion and CMP slurry that can achieve polishing at an adequate rate without producing scratches in the polishing surfaces of wafer working films, and a polishing process for wafer surfaces and a process for manufacture of a semiconductor device using them. A CMP slurry contains polymer particles with a crosslinked structure and a mean particle size of 0.13-0.8 μm. The CMP slurry may contain no surfactant, and may contain the surfactant of not greater than 0.15 wt %. The CMP slurry is used as a polishing agent and a working film of a silicon oxide film, an aluminum film, a tungsten film or a copper film formed on a wafer is polished. In one embodiment, KIO_3 is disclosed. KIO_3 provides the iodate ion (IO_3^-) which oxidizes the surface to be polished and produces a hard oxide layer. Although iodate ions may be present in the slurry, no halogen or polyhalide ions as recited by Applicant are provided.

Wu discloses a method for cleaning the slurry remnants left on a polishing pad after the completion of a chemical mechanical polish (CMP) process is provided. This method is able to substantially thoroughly clean away all of the slurry remnants left on the polishing pad. In the method of the invention, the first step is to prepare a cleaning agent which is a mixture of H_2O_2, deionized water, an acid solution, and an alkaline solution mixed to a predetermined ratio. The cleaning agent is subsequently directed to a nozzle formed in the pad dresser. This allows the cleaning agent to be jetted forcibly onto the slurry remnants on the polishing pad so as to clean the slurry remnants away from the polishing pad. In one embodiment, KIO_3 is disclosed. KIO_3 provides the iodate ion (IO_3^-) which oxidizes the surface to be polished and produces a hard

oxide layer. Although iodate ions may be present in the slurry, no halogen or polyhalide ions as recited by Applicant are provided.

Nishimoto discloses an aqueous dispersion for CMP that has low generation of coarse particles from abrasive particles or the like during storage or transport. The aqueous dispersion for CMP according to the first aspect of the invention comprises abrasive particles, an amphipathic compound and water. The aqueous dispersion for CMP according to the second aspect of the invention comprising abrasive particles and water, wherein a boundary film is formed at the interface between the aqueous dispersion and the air. The boundary film may comprise an amphipathic compound. Although in one embodiment identified by the Examiner hydrochloric acid is disclosed, as noted above although halide ions (Cl^-) may be available in solution, no halogen or polyhalide ions as recited by Applicant are provided.

The cited references, either alone or in combination, fail to disclose or suggest Applicant's slurry solution recited in amended claim 1 which includes at least one halogen containing species selected from the group consisting of a polyhalide ion, I_2, Br_2 and F_2. Accordingly, Applicant submits that amended claim 1 and its respective dependent claims are patentable claims. Regarding the selectivities recited in the various dependent claims of claim 1, such as claims 19-23 and 33-37, with claims 33 and 37 being closely related independent claims, Applicants' novel slurry composition provides improved selectivity values over the cited art which cannot be said to inherently provide the outstanding recited selectivity values because of the now clear differences in the claimed slurry composition as compared to the cited art.

Applicants have made every effort to present claims which distinguish over the prior art, and it is believed that all claims are in condition for allowance. However, Applicants invite the Examiner to call the undersigned if it is believed that a telephonic interview would expedite the

prosecution of the application to an allowance. No fees are believed due with the filing of the above Amendment. However, the Commissioner for Patents is hereby authorized to charge any deficiency in fees due with the filing of this paper or during prosecution of this application to Deposit Account No. 50-0951.

Respectfully submitted,

AKERMAN SENTERFITT

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Gregory A. Nelson
Registration No. 30,577
Neil R. Jetter
Registration No. 46,803
P.O. Box 3188
West Palm Beach, FL 33402-3188
Tel: 561-653-5000